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Michigan at a Climate Crossroads:

Strategies for Guiding the State in a Carbon-Constrained World

Executive Summary

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Executive Summary

The *Michigan at a Climate Crossroads: Strategies for Guiding the State in a Carbon-Constrained World Project* (MCCP) analyzed the greenhouse gas (GHG) reduction potential and economic effects of eight state-level strategies. Using standard modeling techniques, the MCCP demonstrates that enacting policies to reduce GHG emissions can positively affect the state's economy. Enacting a set of state-level GHG emission reduction policies has the potential to reduce Michigan GHG emissions by 84 million metric tons of carbon equivalent (MMTCE) by 2025, while increasing gross state product (GSP)[i] by an average of $380 million per year, and increasing state employment by roughly 3,400 full-time jobs. (See Table 2.)

The MCCP builds on the results of the *Michigan Greenhouse Gas Inventory 1990 and 2002* (Inventory) conducted by the Center for Sustainable Systems at the University of Michigan. The Inventory indicates that total statewide GHG emissions increased 9% from 57.4 MMTCE in 1990, to 62.6 MMTCE in 2002. In 2002, 33% of Michigan GHG emissions resulted from the production of electricity in the state, 26% from the transportation sector, and 17% from industrial operations.[ii] Beyond providing a baseline for Michigan GHG emissions, the Inventory highlights opportunities for improvement. Across the United States, state and local governments are leading efforts to develop policy approaches to GHG emissions management. As of September 2006, 29 states had developed State Action Plans (also referred to as Climate Action Plans) specifically targeting GHG emissions reductions; the state of Michigan had not. The MCCP serves to help Michigan legislators understand proactive mechanisms for reducing emissions and to determine their economic impact.

In February 2007, the Intergovernmental Panel on Climate Change reported that the observed increase in global average temperature over the past 50 years is very likely (>90% certainty) due to the observed increase in anthropogenic GHG emissions. The MCCP provides crucial strategies to help the state become the Midwest's leader in climate change policy. These results emphasize that by focusing on energy efficiency, fuel switching, carbon sequestration, and renewable energy, the state can realize economic benefits. Additionally, this report supplements the findings of the Michigan's 21st Century Energy Plan.[iii] A responsible economic development strategy for Michigan should position the state to respond to the impact of impending federal policies intended to reduce GHG emissions. Whether such policies take the form of a mandatory cap-and-trade system, taxes on GHG emissions, or other mechanisms, aggressive action will stimulate and encourage clean energy technology innovations and efficiency improvements that can provide significant economic benefits to the state. By taking immediate action, Michigan could realize the economic benefits generated by GHG reduction policies. In a carbon-constrained world, the economic benefits of greenhouse gas reductions will likely be even greater.

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[i] Gross state product is a measure of the total economic output of a US state.
[ii] Bull, P., McMillan C., and Yamamoto A. (2005). *Michigan Greenhouse Gas Inventory 1990 and 2002.* Master's Thesis, School of Natural Resources and Environment, University of Michigan: Ann Arbor. Retrieved Jan. 2006 from: http://css.snre.umich.edu/css_doc/CSS05-07.pdf
[iii] Michigan Public Service Commission (2007). *Michigan's 21st Century Energy Plan.* Lansing, MI. Retrieved Jan. 2007 from: http://www.dleg.state.mi.us/mpsc/electric/capacity/energyplan/index.htm

The MCCP Team worked with over 150 regional stakeholders in the industrial, commercial, higher education, government, and non-profit sectors to develop policy options and parameters for MCCP modeling. The team constructed GHG models for each policy and utilized the Regional Economic Modeling, Inc. (REMI) Policy Insight Tool, in combination with the Energy 2020 model, to determine the economic effects of each policy. The team analyzed the following eight policies:

1. **Renewable Portfolio Standard (RPS)**: The RPS policy increases production of renewable energy fed into the electric grid and reduces fossil fuel consumption in the electric sector. The team analyzed two RPS policies: one requires regulated utilities to provide 8% from qualifying renewable sources by 2015, the other requires 10% by 2015, and 20% by 2025.[iv]
2. **Appliance Energy Standards**: Appliance efficiency standards reduce the energy consumed by common industrial, commercial, and household appliances. This policy requires appliance efficiency levels above those mandated by federal standards if already covered, and imposes new standards for appliances not already covered. MCCP modeled the effects of Michigan State Bill 1333.
3. **Alternative Fuels**: Alternative fuels policies promote the production, distribution, and use of bio-based renewable fuels for the motor vehicle transportation sector. The team analyzed two policy alternatives: one, a production tax credit for ethanol production, and two, a renewable fuel standard for state motor fuel usage.
4. **Carbon Sequestration**: This policy is intended to capture the carbon sequestration potential of tree plantings on 1% and 10% of marginal agricultural lands. This policy is designed as a cost-share between non-industrial private landowners and the state or federal government.
5. **Building Codes**: To increase energy efficiency in homes, the residential building code policy requires higher R-values for ceiling, walls, floors, windows, and basements in all new single-family homes built in the state. The team analyzed two policies: one roughly equivalent to the International Residential Code (IRC) 2004, and the other a combination of the International Energy Conservation Code (IECC) 2006 and Department of Energy (DOE) insulation recommendations for the state.
6. **Mass Transit Development/Enhancement**: This policy implements a mandatory fuel-switch directed at urban mass transit buses. This policy requires affected entities to switch from diesel to biodiesel (B20).
7. **Alternative Vehicle Technology**: This policy implemented a state-sponsored consumer tax credit for the purchase of alternative vehicle technologies.
8. **Combined Heat and Power (CHP)**: Incentives were designed to increase CHP implementation and utilization in Michigan, in an attempt to introduce more fuel-efficient energy sources, thus reducing the state's GHG emissions. The MCCP assumed Michigan could produce at least 180 MW of electricity by utilizing CHP as a replacement electricity and steam source for appropriate industrial candidates.

[iv] 8% by 2015 refers to the Michigan Sustainable Energy Coalition (MSEC) scenario and 10% by 2015 and 20% by 2025 refers to the MCCP scenario.

For each policy, the MCCP team modeled several scenarios to help understand the different potential effects of the policy. The table below provides a list of scenarios with the greatest GHG reduction potential and their corresponding economic impact.

Table 1. Individual Policy Results:
GHG Reduction Potential and Economic Effects (2007 - 2025)

Policy	Cumulative GHG Savings (MMTCE)[1]	Avg. Annual Δ GSP (2000 $Millions)[2]	Avg. Annual Δ Job-Years[3]
20% Renewable Portfolio Standard	**39.9**	**64.6**	**881**
Renewable Motor Fuel Standard	**13.2**	**283**	**1,700**
Carbon Sequestration	**10.3**	**-46.7**	**- 212**
Ethanol PTC	**8.45**	**504**	**2,970**
Appliance Standards	**7.35**	**38.3**	**437**
Building Codes	**6.83**	**54**	**644**
Combined Heat and Power	**6.09**	**-13.6**	**-81**
Mass Transit Fuel Switching	**0.13**	**4.48**	**31**

1. MMTCE: Million Metric Tons of Carbon Equivalent.
2. GSP: Gross State Product.
3. Job-Years: Average increase in employment over a baseline on a year-by-year basis. For example, 100 job years is equivalent to either 10 jobs lasting 10 years or 100 jobs lasting one year.

Note: Negative numbers are due to large government subsidies.

Table 2. Summary of Results:
Cumulative Impact of MCCP Policies (2007-2025)

	GHG Emissions Reductions	Avg. Annual Δ GSP, $	Total Jobs Created
MCCP Policies[1]	84 MMTCE	380 Million	3,400

1. This table represents an estimate of impact from implementing a subset of the MCCP policies, selected to eliminate potential overlapping impact. The policies included in these cumulative figures are Renewable Portfolio Standard, Appliance Standards, Renewable Motor Fuel Standard, Carbon Sequestration, Building Codes, and Combined Heat and Power.[v]

The MCCP findings show that the modeled policies represent a range of GHG emission reduction potentials. If state GHG emissions continue to grow by 9% every 12 years (consistent with the Inventory's findings), Michigan GHG emissions in 2025 are predicted to be 74.6 MMTCE. By implementing of a set of the MCCP modeled policies, the state could cut emissions to approximately 65.7 MMTCE, reducing projected GHG emission levels by 12%. However, the modeled policies only slow the overall growth rate of the state's GHG emissions, and are not sufficient to reduce emissions below 2002 levels. Thus, these policies represent only a first step. The state will need to take actions more substantial than simply implementing the policies modeled by MCCP to significantly reduce emissions and help avoid the adverse consequences of global climate change.

[v] Specific policy scenarios included in this result include: MCCP RPS (20% renewable by 2025), Renewable Motor Fuel Standard--Cellulose and Corn Based Ethanol Supply (25% RFS by 2025), Carbon Sequestration--10% magland planted with conifers (CRP funding), Appliance Efficiency Standards--SB 1333 (Introduced by Senator Brater), Building Codes--MCCP 2006 (IECC 2006 and DOE Insulation recommendations according to climate zones), and Combined Heat and Power Incentives--180 MW, 6,570 hr/yr ($0.05/ kWh state subsidy).

MCCP modeling indicated that the combined economic effects of these policies are a net positive for the state, with all but two policies resulting in net positive economic effects. As with all policies, the benefits and costs vary within and across sectors. While average annual impacts are mostly positive, some individual policies did have negative annual GSP and employment figures. Additionally, economic modeling did not account for a future price of carbon. Therefore, MCCP considers reported results to be conservative estimates for the economic benefits of these policies in a carbon-constrained world. The Chicago Climate Exchange has operated a voluntary carbon-trading market since 2003, in which carbon prices range from $3.67 -$18.33/MTCE.[vi] Under this price scenario, the cumulative MCCP GHG emission reductions (84 MMTCE) would be roughly valued between $308 million and $1.54 billion by trading the carbon offsets that these policies produce. While it was not possible for the MCCP team to model a price of carbon due to the uncertainty of future climate legislation, various federal climate bills provide some perspective on the range of potential future carbon prices. The US Department of Energy's Energy Information Administration analyzed proposed bills and predicted future (2025-2030) carbon prices ranging from $52-$180/MTCE.[vii]

The following are summary results of the individual policies.

1. **Renewable Portfolio Standard (RPS)**: Both RPS policies modeled by the MCCP team are effective instruments for reducing GHG emissions and stimulating economic development. By 2025, the 8% RPS reduces cumulative GHG emissions in the electric sector by 20.3 MMTCE. By that year, annual emissions reductions reach 1.4 MMTCE. Over the same period, the 20% RPS reduces cumulative GHG emissions by 39.9 MMTCE. Under this more ambitious policy, annual emissions reductions in this period increase from 1.4 MMTCE with the 8% RPS to 4.5 MMTCE. Most emissions reductions are achieved by new renewable electric generation (mostly wind and biomass) displacing the development of future coal and natural gas plants.

   These GHG reductions can be achieved while producing modest, yet positive, economic benefits. Annually, the 8% RPS contributes an average of $144 million to the GSP, while the 20% RPS contributes an average of $64.6 million. (If the modeling period were extended beyond 2025, the 20% RPS would show greater economic benefits.) The construction sector realizes economic benefits by producing new renewable electric generating facilities.

2. **Appliance Energy Standards**: By 2025, Michigan could experience a reduction of 7.35 MMTCE of GHG emissions and an average annual growth in GSP of $38.3 million as a result of implementing SB 1333. This translates roughly into a total cumulative savings of $1.89 billion from reductions in end-use electricity consumption and $14.2 million from reductions in end-use natural gas consumption. Appliance efficiency standards resulted in significant in-state GHG

[vi] Chicago Climate Exchange prices have ranged from $1.00-$5.00/metric ton of CO_2-equivalent since its founding in 2003. Historical prices retrieved Mar. 2007 from: http://www.chicagoclimatex.com/trading/marketData.html.

[vii] Energy Information Administration (2007). *Energy Market and Economic Impact of a Proposal to Reduce Greenhouse Gas Intensity with a Cap and Trade System* (Washington, D.C.) projects an allowance price of $14.18/metric ton of CO_2e in 2030. Energy Information Administration (2006). *Energy Market Impact of Alternative Greenhouse Gas Intensity Reduction Goals* (Washington, D.C.) projects an allowance price of $49/ metric ton of CO_2-e in 2030, for the most aggressive greenhouse gas intensity reduction scenario analyzed.

emissions reductions and job growth and increases in GSP. The majority of the benefits related to GHG emissions reductions are attributed to the reduction in fuel consumption by the utility sector. The majority of the benefits related to economic impact are attributed to the redistribution of consumer spending as a result of savings on fuel and electricity spending.

3. **Alternative Fuels**: The alternative fuels policies, Ethanol Production Tax Credit and Renewable Fuels Standard, present similarly positive effects. Fuel cycle GHG emissions are dramatically reduced from the Michigan transportation sector by shifting a proportion of motor fuel usage from petroleum-based fuels to bio-based fuels. This transition also provides a significant economic benefit, as a state that imports nearly 100% of its conventional gasoline will move to an increasingly locally supplied fuel system. Through the pursuit of in-state bio-fuel production, Michigan can obtain significant GHG emission reductions, realize economic benefits from a more localized fuel system, and take steps to reduce its dependence on foreign oil.

4. **Carbon Sequestration**: By 2025, Michigan can sequester 10.3 MMTCE by planting conifers on 10% of the state's marginal agricultural land. The economic effects of this policy, however, are negative due to the cost of planting trees by participating landowners and government. These costs could be reduced if a price of carbon were factored into the economic model; the MCCP team was unable to include a price of carbon ($/MTCE) due to the uncertainty of future climate legislation. Nevertheless, the Chicago Climate Exchange (CCX) currently operates a carbon trading market and, since 2003, prices have ranged from $3.67/MCTE to $18.33/MTCE. Considering the 10.3 MMTCE sequestered by planting 10% of marginal agricultural land with conifers and the CCX's range of carbon prices, this policy could generate $37.8 million to $189 million through the trading of carbon forestry offsets. While total tree planting costs are approximately $204 million, this revenue would decrease the magnitude of the negative economic effects. Pursing Conservation Reserve Program funds from the federal government would be an additional mechanism to increase the economic benefits. This policy would be better suited under a carbon-constrained world scenario, in which a price of carbon could create the need for mechanisms, such as carbon sequestration projects, to offset GHG emissions.

5. **Building Codes**: The modeled code equivalent to the MCCP2006demonstrated emission reductions of 6.83 MMTCE, with an average annual GSP contribution of $54 million. Energy conservation achieved through implementation of the code would result in approximately 2.3 million kWh of electricity and 7.8 million therms of natural gas savings by lowering demand for energy needed to heat and cool the new houses. On average each house saves 55.5 kWh and 186 therms per year. The combination of IECC 2006 code and DOE recommendations save 4.87 million kWh and 17.6 million therms per year. On average, this equals 116 kWh and 417 therms of savings per house per year. The per house energy savings translate directly into financial savings for the consumer to spend elsewhere in the economy while reducing the income for the utility sector. These effects, combined with the assumed increased house construction costs of 2%, which were passed directly onto the consumer, yielded a net positive for the state GSP and job-years.

6. **Mass Transit Development/Enhancement**: Fuel-switching in urban mass transit buses demonstrates the potential to reduce GHG emissions, create positive economic effects, and reduce foreign oil consumption. This policy is small in scale (focused only on mass transit buses) and produces the lowest cumulative GHG reductions (0.13 MMTCE) of the analyzed policies. Average annual changes in GSP were $4.74 million and an addition of 33 job-years. A policy with a broader scope, focusing on a larger number of diesel vehicles, could further increase the GHG reduction potential and economic benefits of a fuel-switching policy.

7. **Alternative Vehicle Technology**: Increasing the adoption of alternative vehicles is an important step in weaning the transportation sector off petroleum-based fuels. However, a consumer tax credit is an economically inefficient mechanism to achieve this end.

8. **Combined Heat and Power**: By 2025, Michigan can experience a reduction of 6.09 MMTCE by generating up to 180 MW of power through CHP systems instead of from utilities. Economic modeling for a state subsidy of $0.05/kWh given to CHP adopters to achieve the full 180 MW was a burden on the state, resulting in negative economic impact. Similarly, implementing 180 MW of CHP power in the state without a subsidy resulted in slightly negative impact. Given the uniqueness of Michigan's quasi-unregulated utility sector, the variety of electricity rates, and substantial standby and back-up fees, the state still needs to consider providing incentives for adopting CHP. However, incentives do not need to be as high as $0.05/kWh. Further exploration into variations of state incentives, such as production tax credits and investment tax credits, should be conducted to fully understand potential adoption rates and the range of CHP's potential impact.

Detailed descriptions of the above policies, modeling methods, and results are provided in the full report.

Michigan will need to implement innovative and far-reaching policies to achieve significant reductions in GHG emissions, minimize economic risks, and take advantage of economic opportunities presented by a carbon-constrained world. Starting now can help the state prepare for likely federal action, allow it to assume a leadership position, and stimulate the economy in the process. The policies outlined above can guide the state forward. We have demonstrated that the state can achieve environmental improvements at the same time that it creates positive economic outcomes.